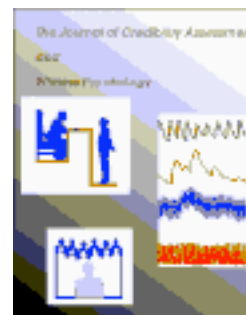


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## **The Physiology of Threat: Remote Assessment Using Laser Doppler Vibrometry**

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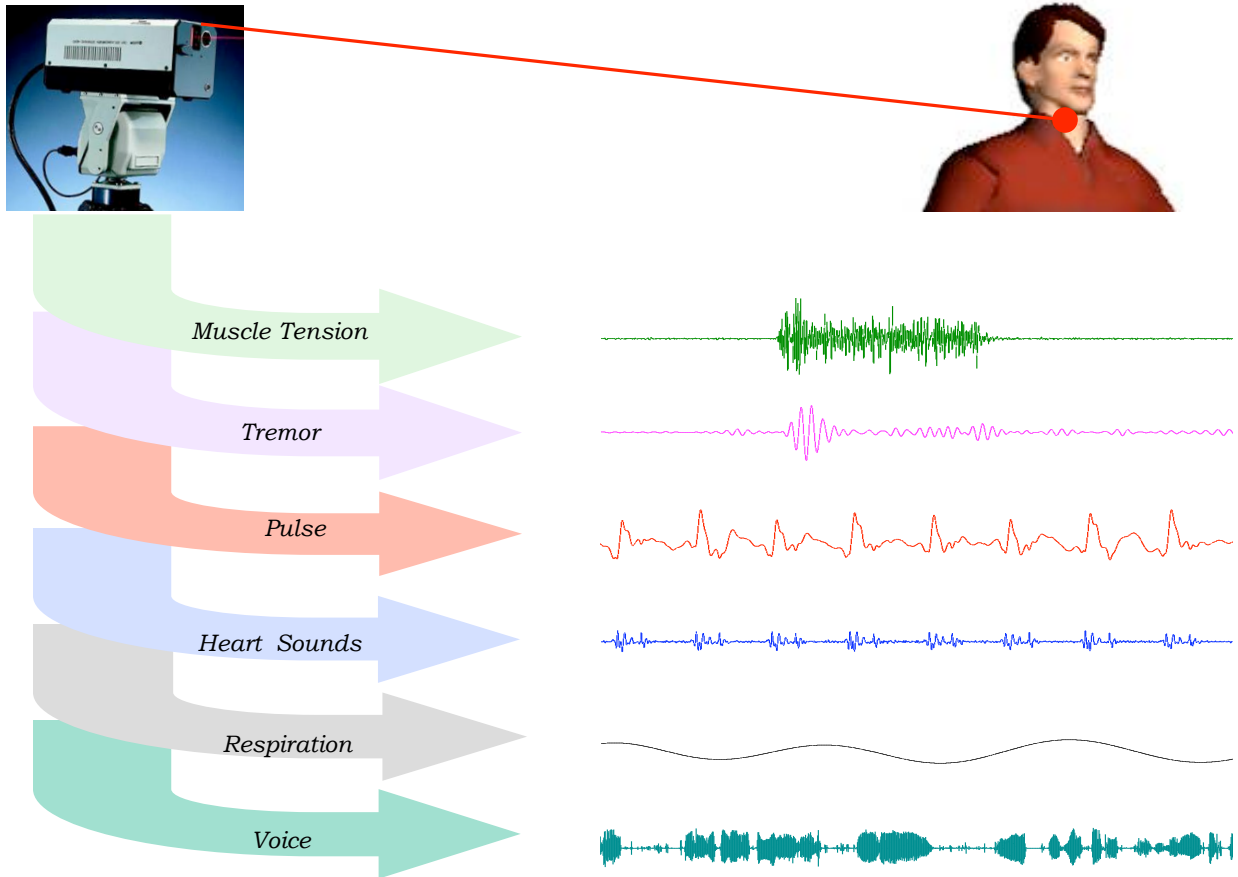
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# The Physiology of Threat: Remote Assessment Using Laser Doppler Vibrometry

**Laser Doppler Vibrometry:  
Remote Recording of Multiple  
Physiological Signals**



## **Overall Premise:**

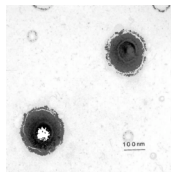
*Internal physiology has mechanical components that can be detected in the form of surface (skin) vibrations.*

- Provide basis for conventional methods based on accelerometry, plethysmography, etc.
- Key to clinical methods based on auscultation, palpation, and percussion of body sounds and movements.

- Multiple forms of activity can be sensed, supporting differentiation among stress and emotional states.
- **Vibrations can be sensed remotely.**



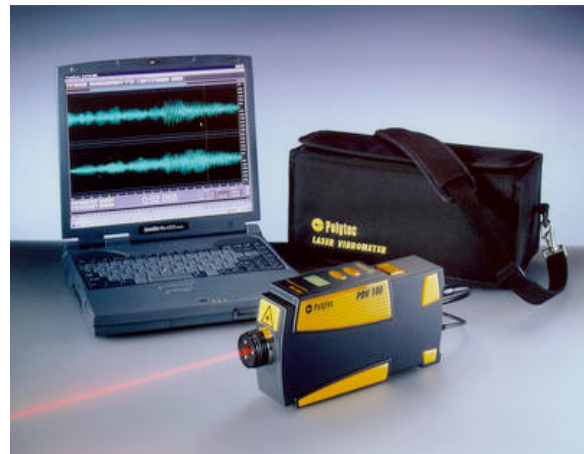
*Works on Doppler principle, using phase-shifted reference beam to yield direction-encoded interference patterns.*



- Laser: 633 nm, 1 mW
- Range: >5 m
- Bandwidth: 0 - >20 kHz
- Sensitivity: <1 nm

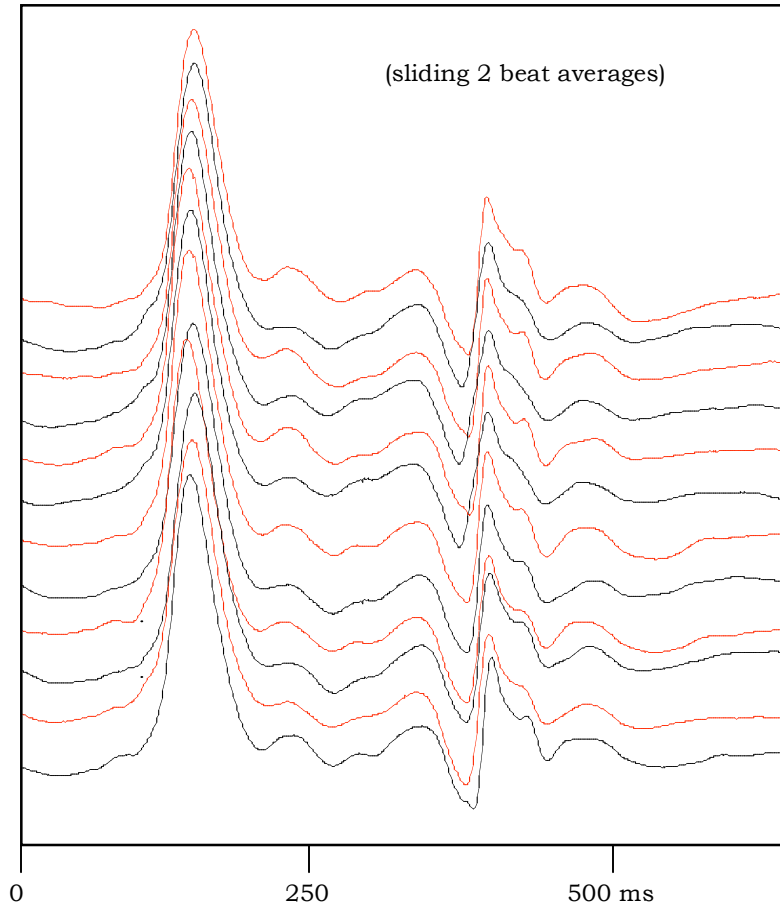


Polytec PSV400 Scanning Vibrometer

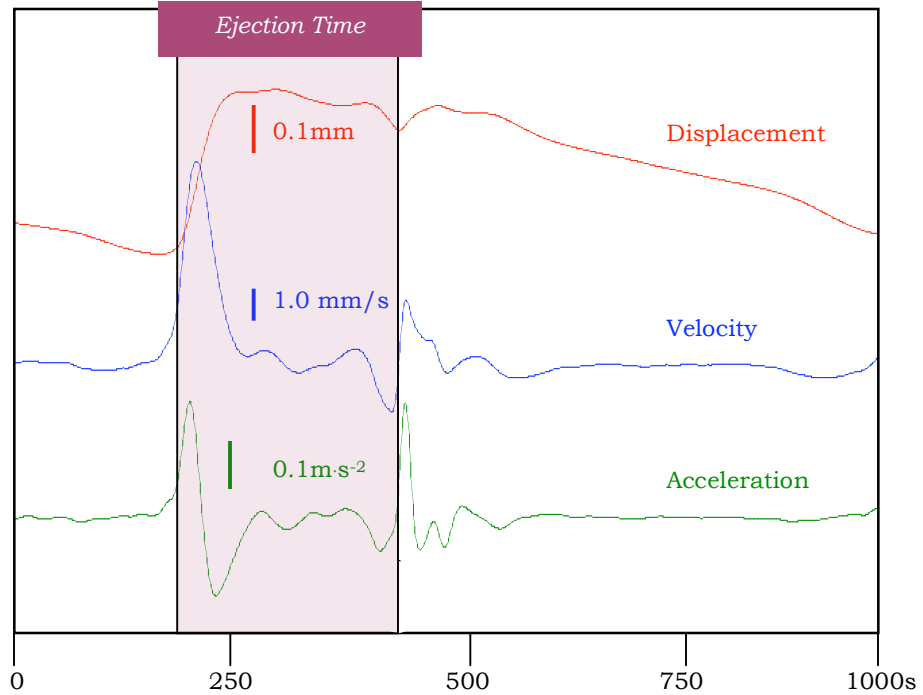


Polytec PDV100 Portable Vibrometer

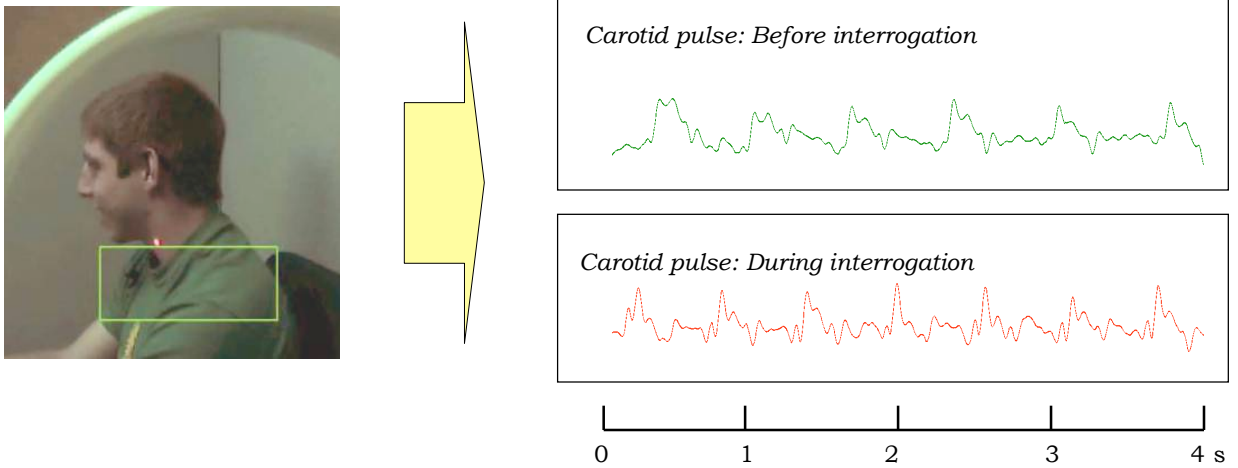
### Carotid Pulse: Beat to Beat Stability



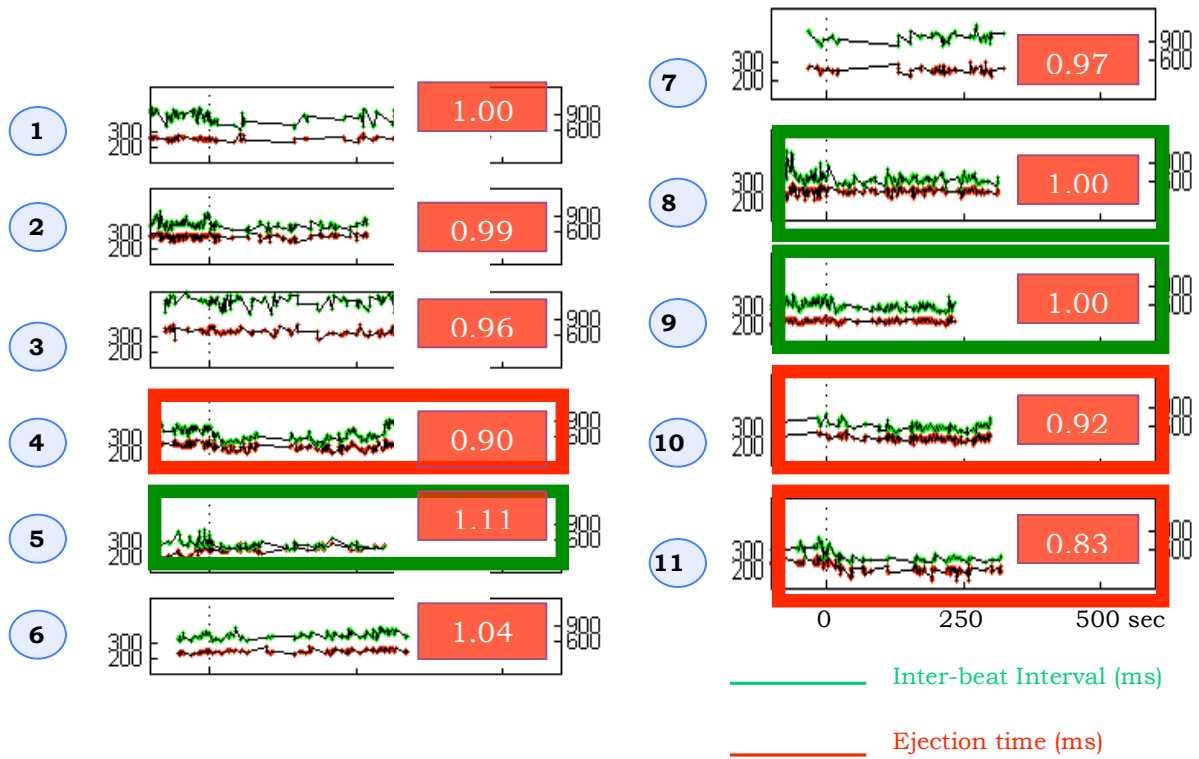
### LDV Carotid Pulse Contour



### Carotid Pulse During Interrogation

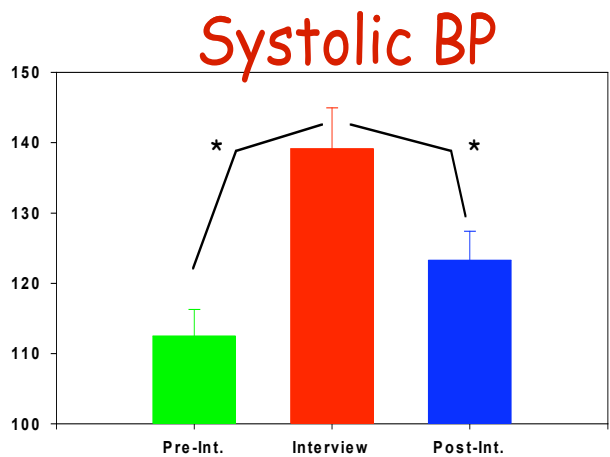
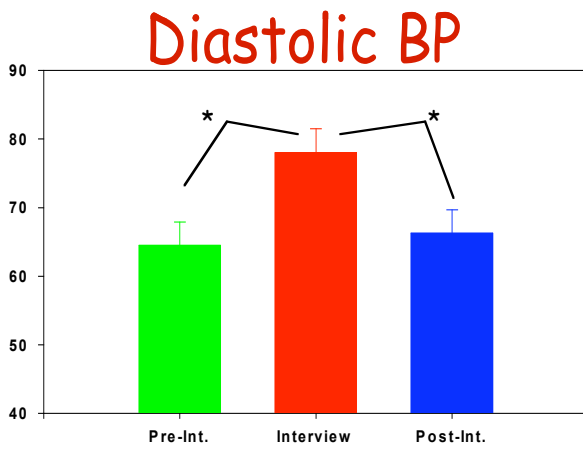
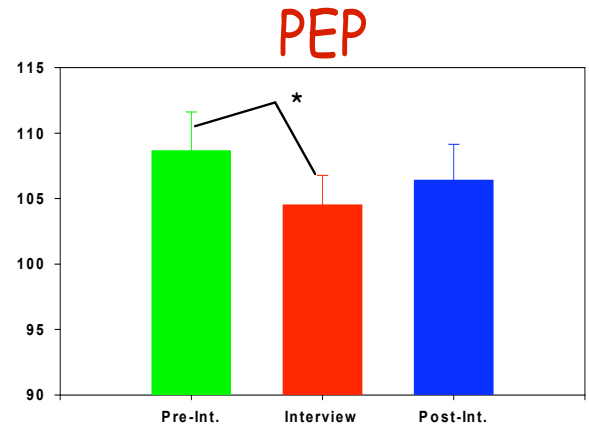
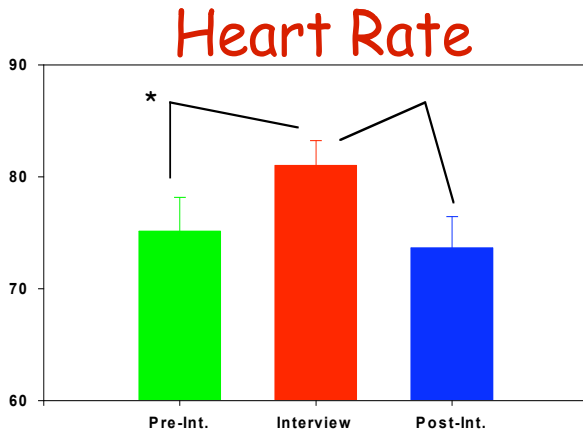


### Interbeat Interval and Ejection Time During Interrogation

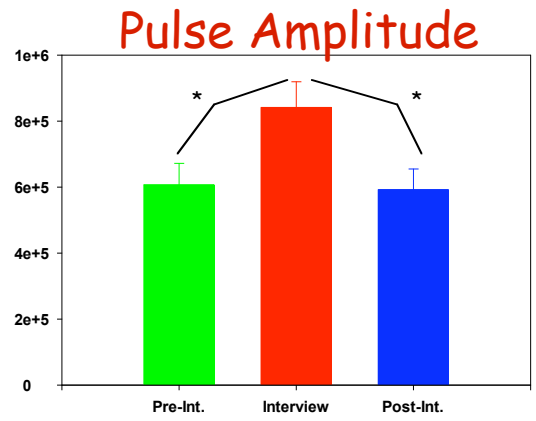
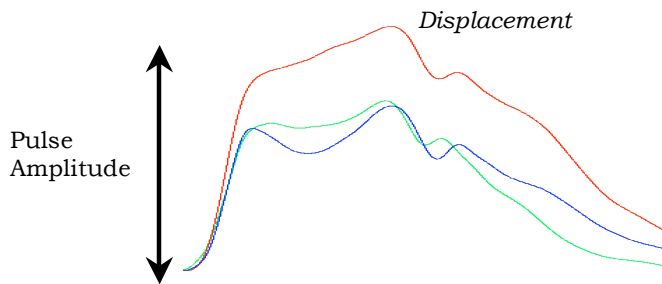
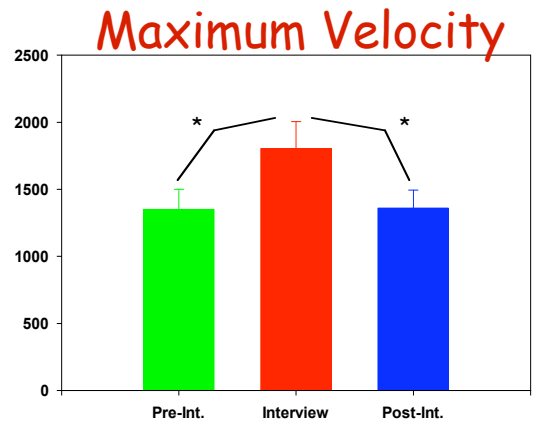
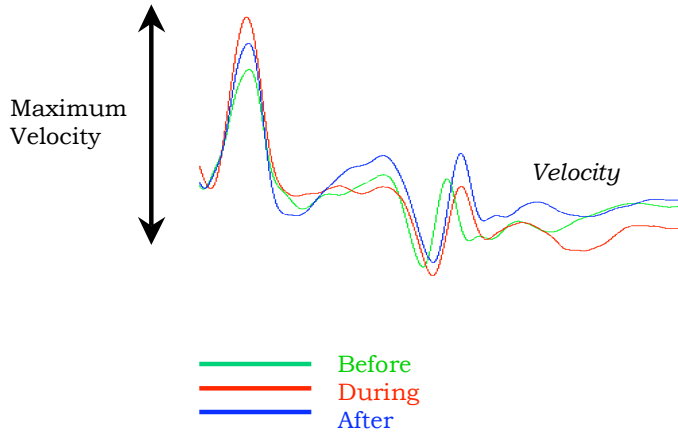


### Stress Interview

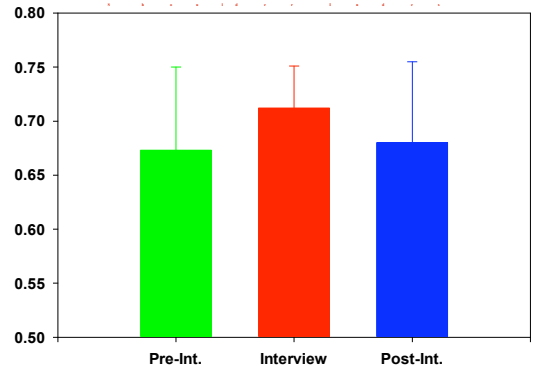
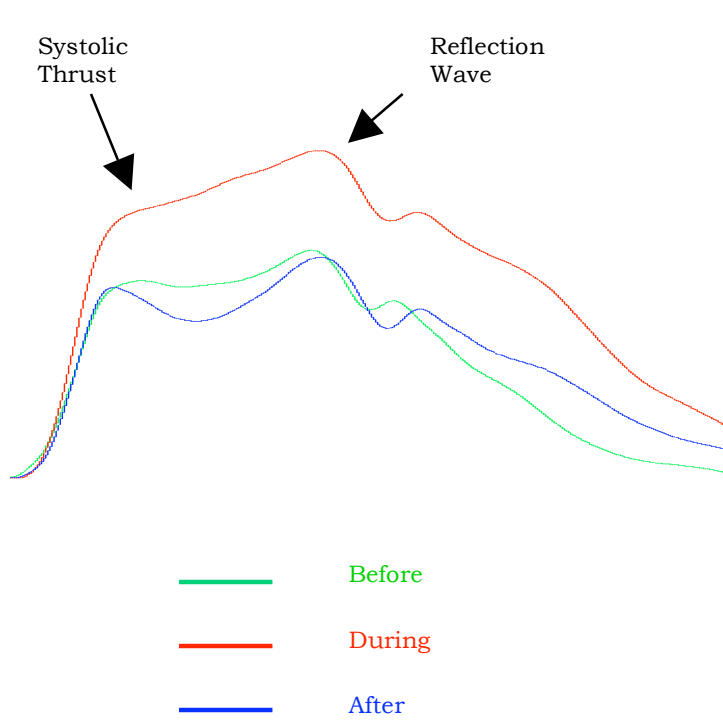
16 min semi-structured, face-to-face interview covering common life stressors (following procedures of Dimsdale et al., 1988).



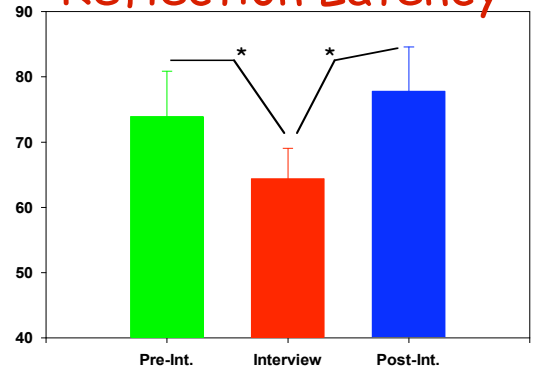
### Carotid Pulse Amplitude



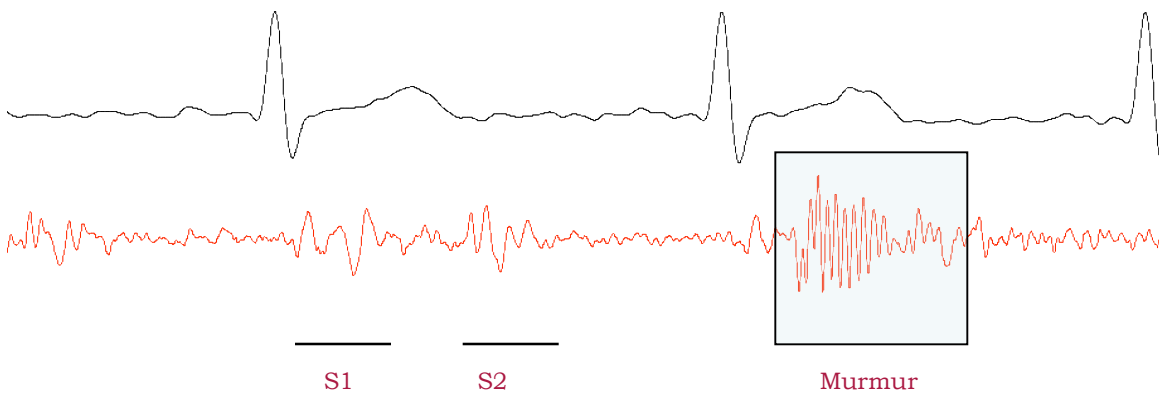
### Carotid Pulse Contour



### Reflection Latency



### Systolic Murmur

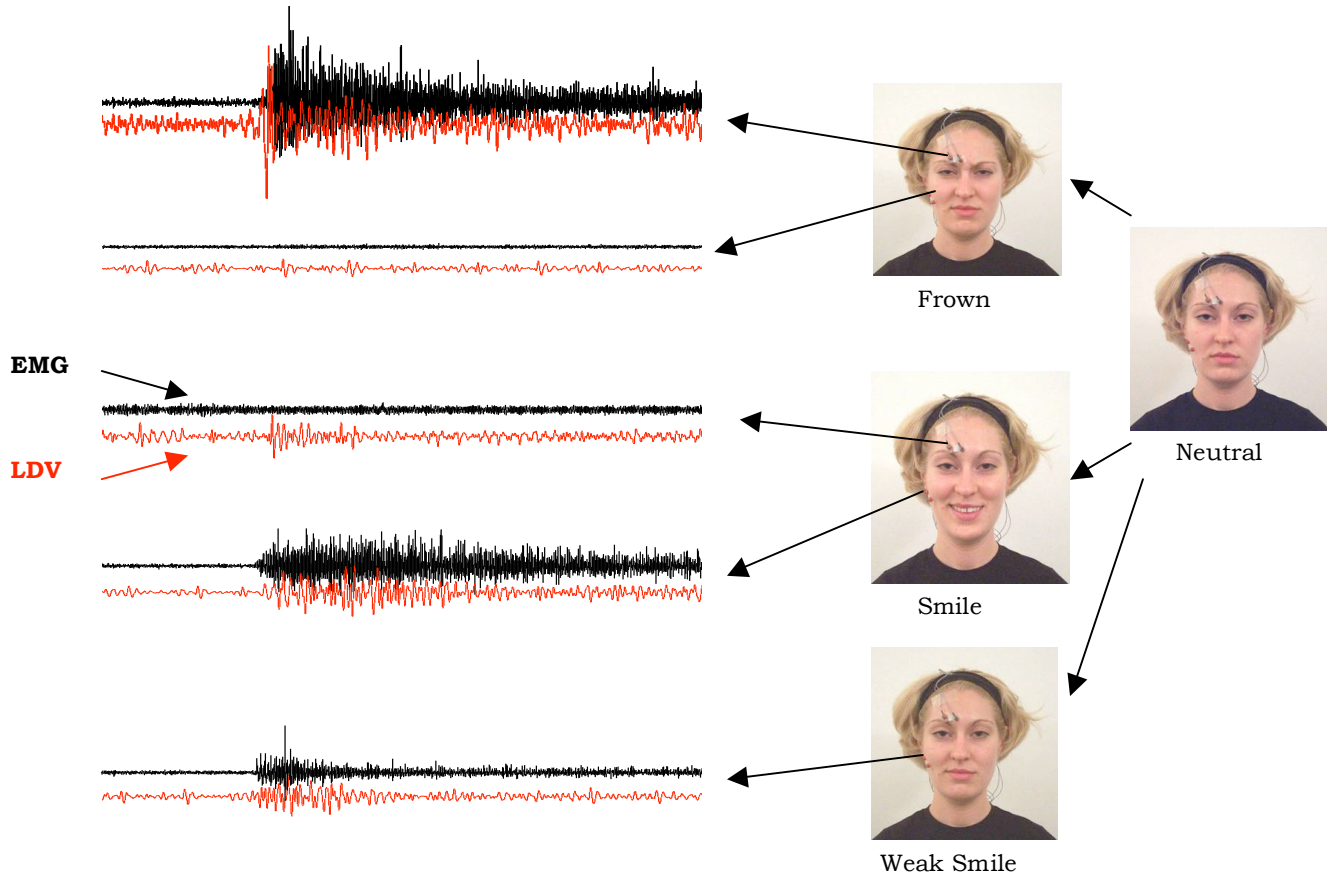




### Muscle Vibrations (Acoustic Myogram)

- First described by Grimaldi, 1665.
- Peak frequency *ca* 10 to 30 Hz.
- Usually recorded using microphones or accelerometers.
- Reflect lateral vibration or expansion of muscle, associated with firing of motor units.
- May be more directly related to force production than is electrical signal (EMG).

### Facial Myography (corrugator, zygomatic)



**Lower Face**  
**(RMS velocity, 16-32 Hz band)**

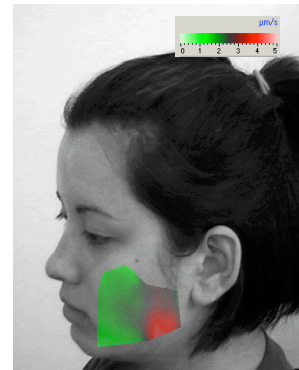
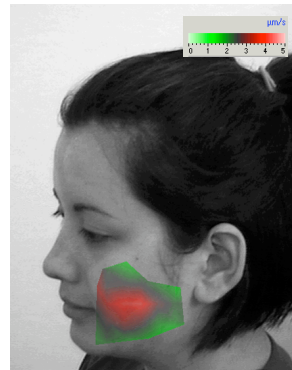
Neutral

AU 20

AU 31

Lip Stretcher

Jaw Clencher



**Upper Face**  
**(RMS velocity, 16-32 Hz band)**

Neutral

AU 1

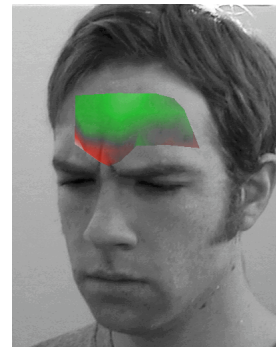
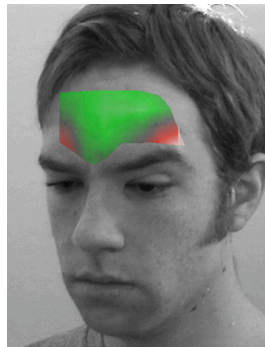
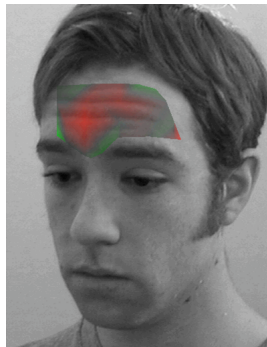
AU 2

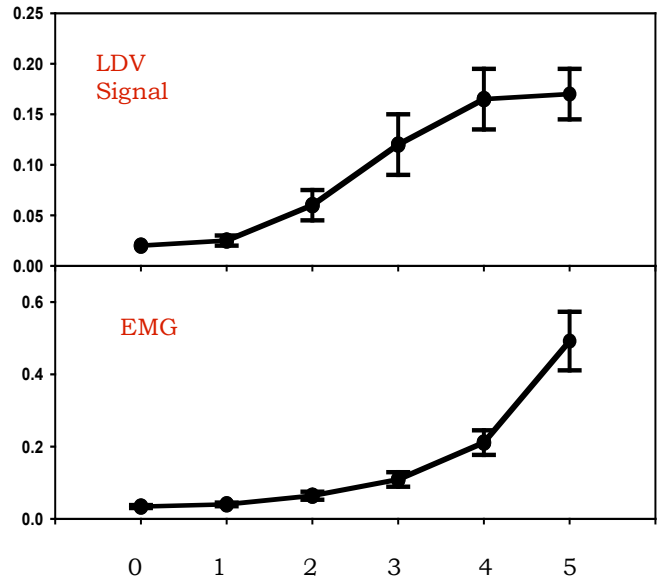
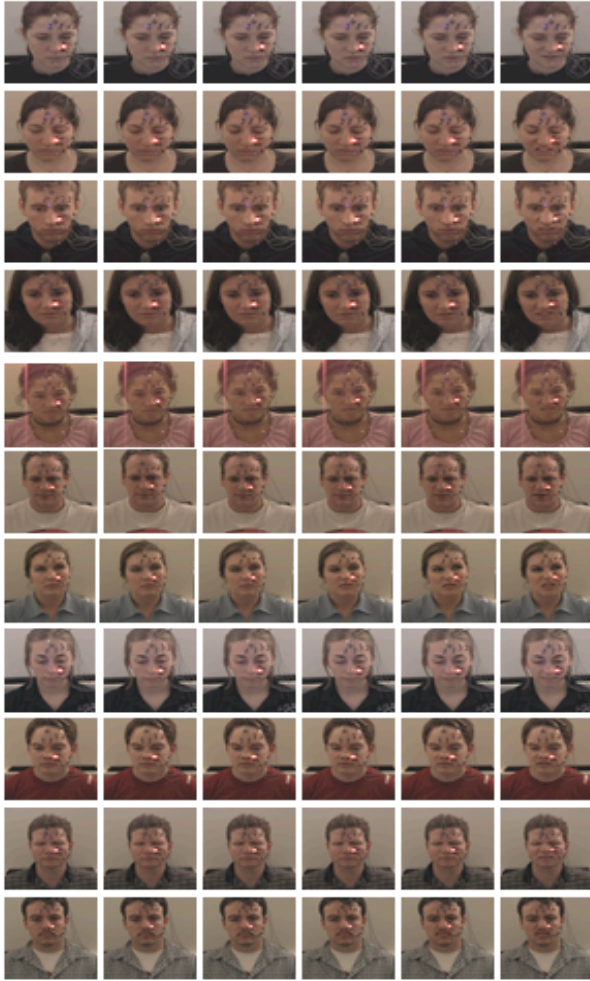
AU 4

Inner Brow Raiser

Outer Brow Raiser

Brow Lowerer





**CONCLUSION:** The LDV method can reliably assess facial muscle activity, associated with emotion and stress, at low levels—below the threshold for visible facial deformations.

### Summary

Laser Doppler Vibrometry (LDV) provides advanced measures in multiple physiological systems relevant to laboratory and field assessment of stress and emotion:

- LDV **cardiorespiratory** recordings yield advanced measures of myocardial and vascular performance, and respiratory effort and sounds.
- LDV **tremor** activity compares favorably with accelerometry, and is responsive to laboratory stressors.
- LDV **muscle** vibratory activity can be sensed from multiple muscles, including facial muscles, and compares favorably with the EMG.

LDV signals are unaffected by environmental noise and other conditions.

LDV signals can be obtained during unconstrained interviews or interrogations.